Studies on the Morphogenesis of the Middle Ear Muscles in Man*

L. CANDIOLLO and A. C. LEVI

Department of Histology and General Embryology (Head: Prof. L. CANDIOLLO) and Department of Normal Human Anatomy (Head: Prof. F. LORETI), University of Turin

Received June 20, 1969

Summary. The time of appearance and subsequent morphogenetic development of the tensor tympani and stapedius muscles in man were investigated in human embryos and foetuses (from 14 to 220 mm C.R. length). It was found that the primordia of both muscles form approximately at the end of the second month of intra-uterine life. The primordium of the tensor tympani muscle is situated laterally to the dilated extremity of the tubotympanic recess. The primordium of the stapedius muscle lies next to the facial nerve and stapedial artery. Differentiation of the muscle fibres occurs earlier in the tensor tympani muscle than in the stapedius muscle. The development of the middle ear muscles parallels that of the various structures of the middle ear with which they are in contact.

Introduction

The various components of the auditory apparatus originate as separate and independent structures which, in the course of their development, eventually assemble to form a functionally unitary system. This is true especially of the organs contained in the middle ear: although their origin differs, when development is complete they form a perfectly integrated whole. In the tympanic cavity the auditory ossicles, connected to one another by means of joints, stretch from the tympanic

* This investigation was supported by a grant from the C.N.R.
membrane, to which the manubrium of the malleus is attached, to the oval window, which contains the footplate of the stapes. These interrelationships of the tympanic-ossicular system offer an explanation for their peculiar function, i.e. the mechanical transmission to the perilymph of the vibrations of the tympanic membrane caused by sound waves. The system is completed by the muscles connected to these structures: the tensor tympani muscle, contained in the canal of the tensor tympani muscle and inserted to the manubrium of the malleus, and the stapedius muscle, contained in a canal in the eminentia pyramidalis, whose terminal tendon is inserted to the neck of the stapes. Although some degree of antagonism between the two muscles cannot be ruled out, recent views tend to conclude that their action is synergic and aimed at modifying the impedance of the entire transmission system, favouring the transmission of sounds of different intensity and pitch.

In man, the organs of the middle ear originate from the first and second branchial arches and from the first pharyngeal pouch. The tubotympanal recess derives from the first pharyngeal pouch. The origin of the tympanic membrane is ecto-endodermal. The malleus, incus, and tensor tympani muscle originate from the mesoderm of the first branchial arch, whereas the stapes and the stapedius muscle originate from the mesoderm of the second branchial arch.

An analysis of the pertinent literature shows that attention has been directed mainly to investigation of the organogenesis of the tympanic membrane and auditory ossicles (Reichert, 1837; Gradengo, 1887; Staderini, 1891; Brun, 1908; Arione, 1923; Richany, Bast and Anson, 1954), whereas little has been reported regarding the development of the tensor tympani and stapedius muscles, often under the form of marginal notes in papers dealing with the middle ear as a whole or with the transmission system.

Gradengo (1887), in a paper on the development of the auditory ossicles, briefly mentions the middle ear muscles which he found clearly differentiated in two human foetuses (40 and 45 mm C.R. length, respectively). He observed that at this stage of development the tensor tympani muscle courses horizontally, externally to the tympanic wall of the otic capsule, and that its insertion to the primordium of the malleus cannot be distinguished; the stapedius muscle lies against the facial nerve and is contained in a groove formed by the posterior extension of the otic capsule.

According to Broman (1899), the primordium of the tensor tympani muscle can be identified at the end of the second month of intrauterine life, whereas the primordium of the stapedius muscle appears later, towards the end of the third month. In its subsequent development the tensor tympani muscle is contained in a connective sheath which is thicker laterally and forms a true ligament at the apex of the muscle (trochlear ligament) around which the tensor tympani muscle bends to reach its terminal insertion to the malleus. The stapedius muscle originates from a small primordium which lies near the otic capsule and travels upwards and forwards towards its insertion to the stapes. A fibrous lamina originates from the lower border of the oval window and envelops the stapedius muscle, giving rise to its characteristic angulation, similar to that observed in the tensor tympani muscle,